Benefits Assessment of Algorithmically Combining Generic High Altitude Airspace Sectors

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In today's air traffic control operations, sectors that have traffic demand below capacity are combined so that fewer controller teams are required to manage air traffic. Controllers in current operations are certified to control a group of six to eight sectors, known as an area of specialization. Sector combinations are restricted to occur within areas of specialization. Since there are few sector combination possibilities in each area of specialization, human supervisors can effectively make sector combination decisions.

In the future, automation and procedures will allow any appropriately trained controller to control any of a large set of generic sectors. The primary benefit of this will be increased controller staffing flexibility. Generic sectors will also allow more options for combining sectors, making sector combination decisions difficult for human supervisors. A sector-combining algorithm can assist supervisors as they make generic sector combination decisions. A heuristic algorithm for combining under-utilized air space sectors to conserve air traffic control resources has been described and analyzed [1, 2]. Analysis of the algorithm and comparisons with operational sector combinations indicate that this algorithm could more efficiently utilize air traffic control resources than current sector combinations.

This paper investigates the benefits of using the sector-combining algorithm proposed in previous research [1, 2] to combine high altitude generic airspace sectors. Simulations are conducted in which all the high altitude sectors in a center are allowed to combine, as will be possible in generic high altitude airspace. Furthermore, the algorithm is adjusted to use a version of the simplified dynamic density (SDD) workload metric that has been modified to account for workload reductions due to automatic handoffs and Automatic Dependent Surveillance Broadcast (ADS-B) [4]. This modified metric is referred to here as future simplified dynamic density (FSDD). Finally, traffic demand sets with increased air traffic demand are used in the simulations to capture the expected growth in air traffic demand by the mid-term.

Table 1 shows the scenarios for which results are available. In the Separate scenario, no sector combinations are implemented. The performance of separate sectors for traffic volumes from 1x-2x is studied. Three scenarios involving the sector-combining algorithm are run. In the Count scenario, the algorithm uses aircraft count to measure workload and the workload threshold is set as the sector monitor alert parameter. The workload measure is simplified dynamic density and the threshold is 70 for the SDD scenario. Both of these scenarios are run with 1x traffic. In the FSDD scenario, the algorithm uses future simplified dynamic density to measure workload with a threshold of 70, and traffic volumes ranging from 1x-2x are used. Finally, the Operational scenario simulates the sector combinations that were implemented on

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the 1x traffic seed day. In current operations, aircraft count is used to measure workload, and the workload threshold is the monitor alert parameter.

Table 1. Simulation Scenarios

Scenario Name	How sectors combine	Sector Workload Metric	Sector Workload Metric Threshold	Traffic Volume(s)
Separate	-	-	-	1.0x, 1.3x, 1.5x, 2.0x
Count	Algorithm	Aircraft count	Monitor Alert Parameter	1.0x
SDD	Algorithm	SDD	70	1.0x
FSDD	Algorithm	FSDD	70	1.0x, 1.3x, 1.5x, 2.0x
Operational	Area supervisors	Aircraft count	Monitor Alert Parameter	1.0x

Figure 1 shows the sector hours [1] required in the Cleveland Center high altitude airspace for each scenario. Sector hours is a measure of the amount of air traffic control resources required to manage a group of airspace sectors for a period of time; lower values indicate more efficient use of resources due to more sector combinations. The Separate scenario uses more than 600 sector hours for this center, regardless of traffic level. Operational sector combinations reduce the number of required sector hours to less than 450 sector hours. The algorithm uses even fewer sector hours than current operations, and the fewest sector hours are required when future simplified dynamic density is the workload metric. As traffic volume increases to two times current traffic, the algorithm is still able to control the traffic with fewer sector hours than were used in the Operational scenario. This implies that even when traffic volumes increase to twice their current levels, no increase in high altitude air traffic control resources will be required to control this airspace.

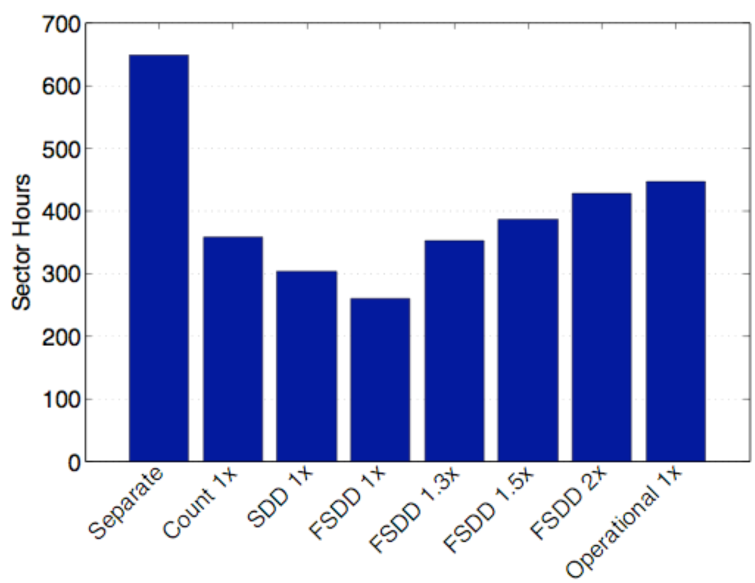

Figure 1. Sector hours for each scenario.

Another benefit of utilizing a sector-combining algorithm is workload balancing. Although this is not the primary objective of the sector-combining algorithm, sector workload balance is desirable. Figure 2 shows the distribution of future simplified dynamic density for separate

sectors and sectors that have been combined. The traffic volume used to generate the data in this figure is 2x current traffic, and several instances of workload above the threshold of 70 are observed. Furthermore, there are many instances where the separate sectors workload is low (less than 30). The workload distribution of the combined sectors is more balanced. When using future simplified dynamic density as the workload measure, the combining sectors algorithm is able to produce a relatively balanced distribution of workload, and can even reduce the number of over-capacity sectors.

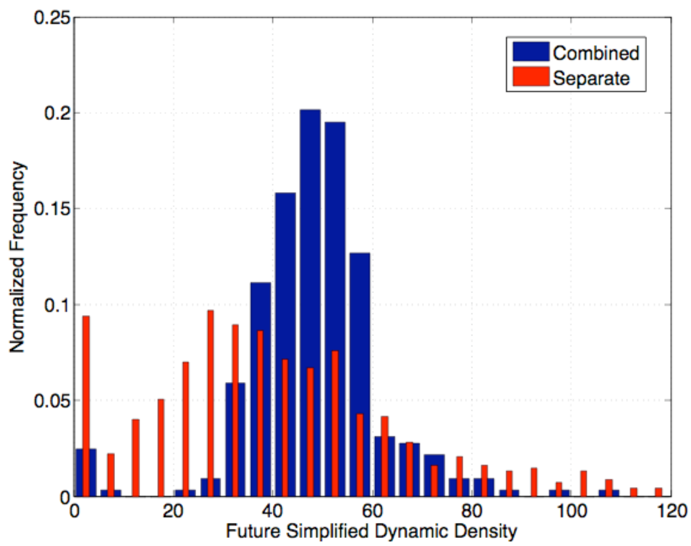

Figure 2. Distribution of FSDD for separate and combined sectors with 2.0x traffic.

For the final paper, more detailed results and analysis will be presented, including an analysis of simplified dynamic density and its components. Inter-center generic high altitude sector combinations will be considered. An alternate measure of workload in the mid-term may be selected and simulated.

References

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